United States Senate
Committee on Commerce, Science, and Transportation
Subcommittee on Surface Transportation and Merchant Marine

Hearing on:
Fatigue and Its Safety Effects on the Commercial Motor Vehicle and Railroad Industries
September 16, 1998

Managing Fatigue in Transportation: No Magic Bullet

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No Magic Bullet

The twenty-four hour global demands of the transportation industry pose unique physiological challenges to the human operators. The operational requirements, technologies, and capabilities of the transportation system have evolved tremendously. However, the human operators who remain central to maintaining a safe and productive system, have not physiologically evolved at all. This has created a direct conflict between operating an around-the-clock global transportation network and human physiological requirements. Twenty-four hour transportation needs result in human fatigue caused by sleep loss and disruption of the internal body (circadian) clock. Fatigue is a known safety risk that can degrade all aspects of human capability and can lead to errors, incidents, and accidents.

There are three formidable challenges in successfully addressing this critical safety issue. First, operational requirements are diverse. For example, the trucking industry incorporates a wide range of driving requirements. Also, the railroad industry encompasses diverse operations, even within one company. The schedules, duty times, rest periods, recovery opportunities, reserve needs, and many other factors can vary widely in one region. These differences can vary further depending upon geography, weather, seasonal requirements, and response to customer needs. Second, there are tremendous individual differences among personnel. For example, age can have a significant effect on the quality and quantity of sleep an individual might obtain, a person's ability to cope with altered shift schedules or night work, and the risk for sleep disorders. Third, the principal physiological factors that underlie fatigue,

sleep and circadian rhythms, are complex. Individually these physiological factors are complex and their intrinsic interaction increases this complexity by several magnitudes.

These challenges—operational diversity, individual differences, and physiological complexity—preclude a simple, single or "one-size-fits-all" solution to address fatigue. Given the extent, diversity, and complexity of these challenges, it may be impractical to expect that fatigue can be eliminated from twenty-four hour transportation operations. However, like many other difficult safety challenges, fatigue can be managed. Effectively managing fatigue will result in a significant reduction in related risk and improved safety. Full acknowledgement of these challenges will be critical to expanding the conceptual and practical approaches required to successfully reduce fatigue-related human error. There is no magic bullet that will eliminate fatigue in the context of current 24-hr operational demands in transportation.

Progress: Many Significant Activities

Over the past 40+ years there has been a significant increase in the scientific knowledge regarding human fatigue, sleep, sleep disorders, circadian factors, alertness, and performance. The last five to ten years has seen the transfer of some scientific findings to applications in operational settings. Significant progress has been made in acknowledging that fatigue is an important safety issue in the trucking and railroad industries. Efforts have been made to more fully research the physiological factors. More importantly, a range of activities in trucking and rail have extended education and a variety of fatigue countermeasures into some operational use. Examples of these activities will serve to highlight some of the progress that has been made on this issue.

The National Transportation Safety Board (NTSB) has aggressively addressed fatigue through a variety of activities over many years. For example, the Board has conducted safety studies examining truck driver fatigue and held public hearings on railroad accidents that included specific panels on fatigue. The NTSB examines fatigue factors in the human performance investigation of accidents. Chairman Hall attended a two-day NASA Ames Fatigue Countermeasures Program Education and Training workshop that provided indepth information on the physiological factors that underlie fatigue and their operational implication. Chairman Hall then led NTSB efforts to cosponsor with the NASA Ames Fatigue Countermeasures Program the first-ever multi-modal symposium on managing fatigue in

transportation. Over 600 people attended from 16 countries and a unique set of proceedings were produced. This spring will mark the tenth anniversary of the NTSB's first safety recommendations regarding fatigue. Many of these recommendations remain valid today.

The Federal Railroad Administration (FRA), under the leadership of Administrator Molitoris, has significantly raised the visibility of fatigue as an important safety issue. Through a variety of actions, Administrator Molitoris has taken an aggressive stance to move the FRA forward regarding fatigue. The FRA initiated, and has coordinated, the efforts of the North American Rail Alertness Partnership (NARAP). NARAP is composed of a diverse industry constituency, including railroads, labor organizations, NTSB, American Association of Railroads (AAR), and others. Emphasizing an inclusive approach, NARAP has investigated a variety of approaches to managing fatigue and produced some concrete actions. Based on the NASA Ames Fatigue Countermeasures Program Education and Training Module, the FRA has produced an education module for use in the rail industry. As Chair of the Department of Transportation Safety Council, Administrator Molitoris has introduced fatigue as a cross-modal issue. Perhaps most importantly, the FRA has supported innovative approaches to addressing fatigue that move beyond a purely hours-of-service structure.

The American Association of Railroads has supported a variety of activities to address fatigue. An inclusive industry/labor task force has been examining work/rest issues from a variety of perpectives, including analysis of operational data. AAR supported the production of a document that compiles the range of fatigue-related activities being conducted by individual railroads. AAR has actively participated in NARAP and visibly acknowledged fatigue as a safety issue for the railroad industry.

Several railroads have initiated a variety of activities to address fatigue. For example, Burlington Northern Santa Fe has undertaken a variety of projects and Conrail had a range of fatigue-related activities underway. The Union Pacific Railroad is implementing a comprehensive, integrated Alertness Management Program that involves extensive educational programs, strategy implementation, innovative scheduling, and a healthy sleep program—all scientifically grounded and guided.

The Federal Transit Administration, through the Transportation Safety Institute, is developing a fatigue awareness course. The American Public Transit Association held a one-day fatigue symposium and several state public transit groups have sponsored meetings and

initiated other activities.

The Federal Highway Administration (FHWA) has conducted and supported a wide range of fatigue-related activities. For example, FHWA collaborated on an extensive truck driver fatigue study with Canadian counterparts that spanned several years and involved a variety of operational, physiological, and performance measures. FHWA and the National Highway Traffic Administration (NHTA) have supported the development and evaluation of technological approaches to fatigue. This has led to a listing of available devices developed and marketed as fatigue/alertness monitors. FHWA supported the first-ever controlled laboratory study of these new technologies in a prestigious laboratory at the University of Pennsylvania under the direction of Dr. David Dinges.

The American Trucking Association (ATA), and its affiliated Foundation, have a history of projects and activities that address fatigue. These range from support for a variety of research studies to symposia. Many ATA sponsored activities and meetings, including those hosted by the Litigation Center and on Driver Training, include one or more presentations on fatigue-related topics. Just this week, the ATA Litigation Center's Annual Meeting had a full day dedicated to addressing fatigue from scientific, operational, and legal perspectives. ATA has developed an education module on fatigue that has been made available to the trucking industry.

Also, some individual trucking companies have initiated activities related to education and the use of fatigue countermeasures.

These are only some examples, and not an exhaustive or complete description, of the various Federal, industry, and individual company activities to reduce fatigue-related risks. These agencies, companies, and industry groups should be applauded for their important efforts and contributions. These efforts, and those of many others, have raised the visibility of fatigue as an important transportation safety issue. In many cases, the specific actions and projects have directly translated into changing operational and individual practices.

Progress: Much More Needed

The diverse efforts to address fatigue thus far should be acknowledged and important contributions should be fully recognized. However, given the scope and complexity of fatigue as a critical transportation safety issue, progress and change have been minimal. Significantly

more progress and concrete changes are necessary. Some examples will illustrate where more efforts are required.

None of the modal transportation hours of service regulations currently reflect the known and well-established scientific knowledge regarding fatigue. The scientific data should not dictate or be the only factors considered in creating hours of service regulation. However, the available scientific knowledge should be used to guide hours of service considerations whenever possible. Updated hours of service regulations should reflect the scientific knowledge and incorporate it where appropriate. Given the three challenges previously identified, "one-size-fits-all" federal regulatory approaches can not be expected to fully eliminate fatigue. Most importantly, any regulatory approach to fatigue must include mechanisms to provide operational flexibility.

A number of successful educational activities have been initiated in trucking and rail. However, overall, most educational activities remain erratic, voluntary, and typically, without scientific oversight. The quality and consistency of information should have some minimal standards to ensure accuracy. There are no formal requirements for education on this issue in any mode.

Technology has addressed and solved many important and complex issues in our society. However, technology is not perfect, it can be misused, and it can introduce new sources of human error. Technological approaches to managing fatigue are gaining visibility and momentum. However, at this stage of development, technology may create more questions than it answers. There is tremendous need for policy discussions that lead to established, consistent implementation. Evaluation procedures and criteria need to be established, perhaps even a certification process. Without some structure, essentially any "device" claimed to be an "alertness" monitor could be used by an operator. What new difficulties and risks will be introduced by these devices? Can someone work as long as the "alertness" monitor in use does not go off? No alarm means that an operator can keep driving a truck or operating a locomotive engine? Technology has great potential as a tool to reduce fatigue-related risks. Significant effort must be made to bring the available technologies even close to implementation. Also, technology has potential as a tool and will not serve as a complete solution. An alert that goes off indicating fatigue, accurately (!), still leaves many issue to be determined: does the alert get recognized by the operator, what action does the operator take in response to the alert (e.g., pull

over or turn it off), and how did the operator get into this situation in the first place? Again, many questions remain to be addressed prior to implementation.

Scientific knowledge on fatigue and relevant physiological factors has dramatically increased. However, there is a significant need for relevant applied research that directly addresses important operational issues. Part of the difficulty in fully incorporating scientific findings into hours of service regulations is that specific issues have not been directly examined in solid studies. Clearly, there are many basic research questions that must be investigated. There is a tremendous need to balance these activities with applied research projects that will provide specific answers to identified operational questions.

These are only some examples of how much more effort is required to fully address the diversity and complexity of managing fatigue in transportation.

Future Actions: The Need is Now

The knowledge, resources, and expertise currently exist to make the significant progress required to reduce fatigue-related risks and improve transportation safety. The following eleven areas represent some of the issues and actions that could be taken now to progress this issue forward at a significant pace.

1. Develop scientifically based principles and guidelines to be reflected in hours of services regulations. Create a cross-modal document that allows consistent application of scientific knowledge and principles to all regulatory efforts related to hours of service. Acknowledge that hours of service regulations, in the current operating environment, are necessary but not sufficient to "eliminate" or fully manage fatigue. Some boundaries should be established that incorporate, as appropriate, relevant scientific findings. Any hours of service approach must incorporate and specify mechanisms for operational flexibility.

2. Education and training should be formally required across all transportation modes. In light of the many current training requirements for other safety issues, the need for information on fatigue-related issues is clear. This education could include information on the physiological factors that underlie fatigue, misconceptions, and effective strategies to improve alertness and performance in operational settings. The information provided should be scientifically accurate and consistent, with appropriate tailoring to specific work environments. The

educational efforts should be ongoing and evolve as new information emerges.

2. Strategies known to effectively improve alertness and performance should be fully implemented. Planned naps significantly increase performance and alertness and studies have shown their effectiveness in operational settings. Consistent policies and guidelines should be established with specific applications tailored to the operating environment. Many other strategies and factors, for example, caffeine and lodging, have tremendous potential for improved use and effective applications.

3. Technology approaches are emerging that have great potential as a relevant and effective tool to address fatigue. Discussions should begin now on establishing appropriate use policies, standardized evaluation criteria, and mechanisms to track and identify the devices that meet criteria. Once implemented, operational evaluations should be conducted to examine how the new technologies are used and what new risks that the technology may be introduced.

4. Sleep disorders pose a known safety risk related to impaired waking performance and alertness. Healthy sleep programs should provide mechanisms to identify individuals at risk for certain sleep disorders (e.g., sleep apnea). It will be critical that appropriate policies be established to protect individual confidentiality and that treatment and followup programs provide the required treatment and support. There is a need for accurate methods to identify individuals at risk for sleep disorders and cost effective strategies to implement them, especially in safety critical positions.

5. Methods and mechanisms should be established to evaluate new emerging strategies and technologies. As scientific knowledge continues to grow and operational demands evolve, new approaches will be suggested and introduced. Accepted procedures for evaluation and mechanisms to track these new methodologies should be established prior to their introduction.

6. Applied research that provides scientific data on specific operational issues should be encouraged and supported. While basic research activities must continue, operational studies that will answer a concrete applied question should be increased. Many operational issues are complex and may not be amenable to a straightforward scientific study to provide an answer. However, addressing an operational issue or regulatory question with some empirical data will be better than without any scientific input.

7. Standardized approaches to examine fatigue factors in incident and accident investigations should be established. There are many indications that current attempts to quantify the role of fatigue in incidents and accidents significantly underestimate the problem. While there is considerable debate about this issue, a core flaw is the lack of a standardized and accepted methodology to examine fatigue factors. This is another cross-modal issue that has some foundation already established by NTSB investigation approaches, though further work is needed.

8. The most complex and contentious issue in managing fatigue is scheduling. There are many important factors that resist change to existing scheduling approaches (from historical to economical). There is a tremendous need for innovative scheduling approaches that address the operational, economic, and fatigue-related factors in a specific setting. Often a creative scheduling approach can meet these multiple, often competing, needs and provide improvements in each area of concern.

9. To progress fully in addressing fatigue, modal agencies should have clearly established mechanisms to provide timely waivers that support innovation. There should be an opportunity to try new approaches and strategies, within accepted safeguards, that move outside established boundaries.

10. Increased coordination of efforts and leveraging of available resources will be critical to successfully addressing this complex and diverse issue. Federal, industry, and individual company resources should seek mechanisms and forums to move this safety issue forward.

The Future: An Evolving Approach

Successfully reducing fatigue-related risks in transportation will require some innovative concepts and evolving approaches. One evolutionary path involves revising the hours of service regulations to more fully reflect available scientific knowledge but in the context of the many considerations previously outlined. In parallel, the components of an effective Alertness Management Program could be determined and appropriate criteria established. Operators might choose to work according to the established hours of service regulations. An alternative would be to have an established Alertness Management Program and the opportunity to obtain greater operational flexibility outside the hours of service structure. Specific mechanisms would be needed to demonstrate that accepted levels of safety were maintained. In the future, operators may have the opportunity to tailor duty/rest guidelines to their specific operational needs, all under the umbrella of an effective, multi-component Alertness Management Program.

Managing fatigue in transportation is a shared responsibility. Everyone in the system has a role and a responsibility to acknowledge this safety issue and determine what they can contribute to improving the current situation. It has taken many years for the current

operational practices to evolve in the railroad and trucking industries. Action is needed now to address this issue, but all parties must also take the longview. Significant change will require tremendous efforts and time. There are many examples in our society where significant risks have been identified and subsequently reduced. Safety belt use, drunk driving, and varied health risks have all been significantly improved through diverse efforts. However, these also represent areas that have not eliminated the risk but dramatically changed how they are managed.

Fatigue as a critical safety issue in transportation is likely to increase. Twenty-four hour global demands are growing and resources to meet these requirements are being reduced or maintained at steady levels. This increases the pressure on human workload and time demands, often to the detriment of meeting physiological requirements for sleep and a stable circadian clock. However, given the state of scientific knowledge, the visibility of fatigue as a safety issue, and the diversity of current activities there is a tremendous opportunity to make significant progress on this issue. Relevant conceptual approaches, scientific methodolgies, and parallel policy issues currently exist that can be leveraged to move forward. The benefits to society in successfully addressing fatigue are tremendous. Improved safety translates into saving lives and reducing exposure to incidents and catastrophic accidents. There will be benefits from improved alertness and performance that will translate into better health, increased productivity, and a greater quality of life. The risks of ignoring fatigue as a critical safety issue are clear, and the benefits of successfully addressing the issue are equally clear and attainable.

BIOSKETCH

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Dr. Rosekind's research, publications, and presentations have focused on sleep, circadian factors, human fatigue, sleep disorders, and strategies for optimal performance and alertness in operational settings. His many significant accomplishments in translating scientific findings into successful operational use earned him the NASA Exceptional Service Medal, one of the highest awards bestowed by NASA to one of its personnel. Recently, the Flight Safety Foundation honored Dr. Rosekind with a Presidential Citation for "Outstanding Achievement in Safety Leadership."

For seven years, Dr. Rosekind was Principal Investigator of the Fatigue Countermeasures Program in the Flight Management and Human Factors Division at NASA Ames Research Center. During his tenure at NASA, he contributed to operationally relevant research, accident investigation, aviation regulation, and to the entire aviation community through education and other activities. Dr. Rosekind led the team that demonstrated the effectiveness of planned in-flight cockpit rest opportunities to increase pilot performance and alertness, a strategy now used by commercial and military air carriers throughout the world. Dr. Rosekind developed a structured approach to examining fatigue factors in accident investigations and, at the request of the National Transportation Safety Board (NTSB), he applied this approach in the investigation of a DC-8 accident. Based on the results of this analysis, the NTSB cited fatigue as a probable cause for the first time in a major U.S. aviation accident. Dr. Rosekind directed the efforts of an International Scientific Working Group that developed the first scientifically derived Principles and Guidelines for duty and rest scheduling in commercial aviation. This work was used as a critical resource for the Federal Aviation Administration's (FAA) proposed rulemaking on the issue. In collaboration with the Flight Safety Foundation, these Principles and Guidelines were adapted to address flight/duty/rest issues in corporate aviation. Emphasizing the importance of accurate, relevant information, Dr. Rosekind developed the most extensive and successful education and training program on fatigue countermeasures for aviation operations. This NASA education program has been successfully transferred through 29 training workshops involving 630 participants from hundreds of organizations from around the world. The program is currently provided to 75 organizations reaching approximately 125,000 flightcrew and others. In another activity, Dr. Rosekind was co-chair, with the Honorable Jim Hall, Chairman and Ms. Julie Beal of the NTSB, of the first multi-modal symposium, entitled "Managing Human Fatigue in Transportation." The symposium attracted 600 participants from 16 countries and produced unique proceedings. Dr. Rosekind has transferred these scientific findings and activities from the aviation environment into practical and beneficial use in many diverse work settings. These accomplishments have been recognized through honors and awards that include a NASA Ames Honor Award for Team Activities and a NASA Group Achievement Award.

Prior to his tenure at NASA, Dr. Rosekind was the Director of the Center for Human Sleep Research, a component program of the Stanford Sleep Disorders Center in the Stanford Medical School. His academic credentials include an undergraduate degree with honors from Stanford University, his Ph.D. from Yale University, and postdoctoral training at Brown University.